A REVISION OF *NITELLA CRISTATA* BRAUN (CHARACEAE) AND ITS ALLIES.

Part II. Taxonomy.

By Mary B. Williams.*

(Six Text-figures.)

[Read 28th October, 1959.]

Synopsis.

Evidence that certain key characters may be subject to modification by the environment is used in a revision of some of the dioecious Pluricellulatae of the genus *Nitella* Ag. em. Braun (Characeae). *N. cristata* Braun and *N. diffusa* Braun and Nordstedt are redefined, two new species are described, and a key to the four species is given.

Introduction.

The three taxa *Nitella cristata* Braun, *N. cristata* var. *ambigua* Braun, and *N. diffusa* Braun were not satisfactorily distinguished in the original descriptions and have given much difficulty to subsequent workers. Their taxonomic history is outlined and a tabular comparison of their diagnostic characters is made by Chambers and Williams (1959), who also show that emphasis on length of fertile whorls as a key character has been misplaced because it is readily modified by environment. Accordingly, the *N. cristata* group is here revised.

Material borrowed from Australian herbaria (listed below) proved to be limited in quantity, collected chiefly from localities close to early settlement areas, and often insufficient for determination. It was supplemented by the writer's own collections.

More than two hundred specimens were examined from the writer's collections (designated MBW) and from the following institutions: Queensland Herbarium and Botanic Gardens, Brisbane (BRI), National Herbarium of New South Wales (NSW), and National Herbarium of Victoria, Melbourne (MEL). No other Australian herbaria had specimens of the group. Overseas material was not sought, as the only likely source was Berlin-Dahlem Museum where all the algal specimens were destroyed in the war (Alston, 1948).

All specimens except those from Brisbane and one incomplete set of the writer's duplicates were damaged or destroyed by fire at the University of New England in February, 1958. The Melbourne collection, containing types and specimens determined by Nordstedt, fortunately suffered less damage than others. Notes and drawings of specimens examined before the fire were not damaged.

Specimens were examined fresh where possible, otherwise from material preserved in formalin-acetic-alcohol or dried. Fragments of dried material were hydrated in warm 20% ammonium hydroxide, washed, mounted in 10% glycerine, and later made into permanent glycerine jelly preparations. Measurements were made with a calibrated ocular micrometer, oospore dimensions being reported exclusive of appendages (older literature may not be consistent in this respect). Most authors have given such measurements in microns, but millimetres are used here for measurements greater than 100μ in order to avoid reporting digits that are not significant.

Oospore-wall preparations were made by crushing and dissecting ripe oospores which were then softened and cleared of debris in a drop of hot 20% chromic acid, washed, and mounted in glycerine or (after dehydration) in Euparal. Sometimes mounting was in Sirax which has a high refractive index of about 1·66.

Examination of suitable fragments was carried out using oil immersion (×950), and drawings were made with the aid of a camera lucida. In studying fine decorations,

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attention was paid to Welcker's Rule and LO analysis, i.e., with successive adjustment of focus, a protuberance or solid portion shows first as a bright island followed by a dark one (an LO-pattern, from L, *lux*, and O, *obscuritas*); a hollow shows first dark, then bright (an OL-pattern) (Erdtman, 1956).

In an attempt to give more precise descriptions of oospore-wall decorations, terms have been borrowed from the nomenclature of pollen morphology (Faegri and Iverson, 1950), as follows:

Verrucate: decorated with verrucae, more or less isodiametric sculpturing elements which in at least one dimension are greater than or equal to 1μ, and whose greatest diameter is greater than or equal to the height. The elements are neither distally pointed nor constricted at the base. The ratio of smallest to greatest diameter is less than two.

Rugulate: decorated with rugulae, more or less elongated sculpturing elements which in at least one dimension are greater than or equal to 1μ and whose longest diameter is at least twice the shortest diameter.

Baculate: decorated with baculae (i.e., little rods, "Stabchen"), small sculpturing elements neither pointed nor club-shaped, which in at least one dimension are greater than or equal to 1μ and whose greatest diameter is less than the height.

Clavate: decorated with clavae, small sculpturing elements like baculae, but distally thickened so that they are club-shaped.

The term *oospore-wall* is considered preferable to *membrane* because of the special physiological implications of the latter. Other terminology follows that of Wood (1949).

The chromosome number, determined from orcein-crush preparations of fresh antheridia, was n = 9 in all cases examined.

The following descriptions are inclusive, i.e., based on the range of specimens seen rather than on a single representative. A great number of specimens were sterile or immature, precluding definite determination. These have not been cited. In this category are most of the specimens from Queensland Herbarium, which were annotated by Groves and cited by Groves and Allen (1935). *Specimens examined* are arranged by locality, as far as possible from north to south and west to east.

The writer's collections will be housed at the New South Wales National Herbarium, with duplicates issued where possible to the University of Sydney Botany Department, University of New England Botany Department, and other Australian herbaria.

Nitella Agardh em. Braun.

Sect. *Homoeoclemae* J. Groves, *J. Linn. Soc. Lon.*, Bot., 46: 360 (1924).

Subsect. *Arthrodactylae* Groves and Bullock-Webster, *British Charaphyta*, 1: 86, 110 (1920). Series Pluricellulatae.

Nitella cristata Braun, *Linnaea*, 25: 706 (1852), emend.

Kuetzing, *Tab. Phycol.*, 7: 16, Tab. 41, fig. 1 (1857); Braun and Nordstedt, *Abh. preuss. Akad. Wiss. Berlin* (1882): 82, Pl. 6, fig. 165; Nordstedt, *Hedwigia*, 7–8: 185 (1888); Nordstedt, *Acta Univ. Lundens*, 25: 5, 13, 28–29, fig. 17 (1889); Nordstedt, *Proc. Roy. Soc. Vict.*, 31: 1–6 (1918); Groves and Allen, *Proc. Roy. Soc. Qd.*, 46: 49–50 (1935).

Plant dioecious, up to 20 cm. high. *Stem* about 0·5–1 mm. in diameter. *Sterile branchlets* 6 in a whorl, simple or once, partly twice (occasionally 3 times) furcate, about 1–4 cm. long; the secondary rays 2–5, tertiary rays 2–5, dactyls 2–5, rigid, divergent and unequal, usually some longer than 1 mm., with (2)–3–(4) cells, gradually narrowing distally, the ultimate cell short, acute and conical, not longer than twice its width. *Fertile branchlets* usually somewhat shorter than sterile, the whorls often forming heads, but not sharply distinct from sterile. *Oogonia* solitary or two-three together, at any branchlet-node, with 6–9 spirals, 0·48–0·57 mm. long. *Oospore* 0·32–0·45 mm. long, striae 5–7(–8), with a prominent wing. *Oospore-wall* laminated, the outer lamina and wing, or the wing alone, sparsely or densely verrucate, the verrucae about 2–3μ in diameter and 2μ high, and 1–3 diameters apart; the underlying lamina closely

baculate, the baculae slightly less than 1μ in diameter and 1–1½μ high, about 1 diameter apart, some of them almost clavate in outline. *Antheridium* 0·37–0·50 mm. in diameter.

Illustrations: See under varieties. Braun and Nordstedt, *Abh. k. Akad. Wiss. Berlin*, 1882, Pl. 6, fig. 165. Nordstedt, *Acta Univ. Lundens*, 25: fig. 17.

Specimens Seen: See under varieties.

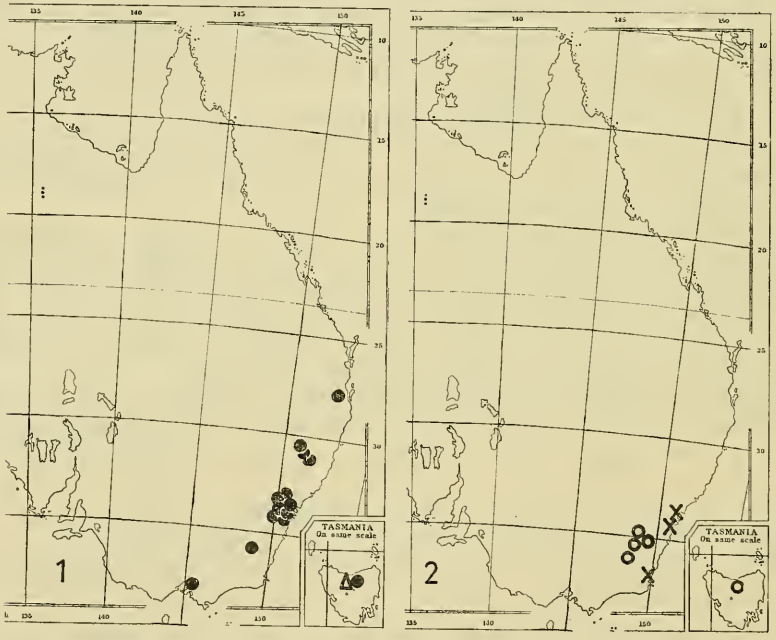
Distribution: See under varieties.

Type Locality: South Esk River, Tasmania.

NITELLA CRISTATA var. CRISTATA. (Figs 1, 3*i*, *j*.)

Lectotype: Charles Stuart 219, "In Tasmania ad flumen South Esk River 1848" (MEL).

Plant dioecious, large, flexible. *Stem* about 0·7 mm. in diameter. *Sterile branchlets* 6 in a whorl, simple or once to partly twice furcate; secondary rays 3–5, tertiary 2–3; dactyl 2–3, usually 2–3-celled, gradually narrowing distally, the ultimate cell conical, acute. *Fertile branchlets* short, twice furcate, forming elongated interrupted heads, the dactyls rigid and diverging, 3-celled, gradually narrowing distally, acute. *Oogonia*



Figs. 1-2.—Distribution of *N. cristata* var. *cristata* Braun △; *N. cristata* var. *ambigua* Braun ●; *N. microteles* Williams ◯; and *N. reticulata* Williams ×.

solitary or 2–3 together at any node. *Oospore* 0·34–0·42 mm. long; striae 5–6, prominently winged. *Oospore-wall* with an outer layer sparsely verrucate on wings alone or on wings plus body of spore, the verrucae about 2μ in diameter and 1½–2μ high, and 2–3 diameters apart; with middle layer which is finely baculate, the baculae less than 1μ in diameter, about 1μ high, and 1 diameter apart, some of them clavate in outline; with inner layer smooth. *Antheridia* unknown.

Other Illustrations: Kuetzing, 1857, *Tab. phyc.*, Pl. 41, fig. 1a.

Specimens Examined: Lectotype, as above.

Distribution: Tasmania, known only from the type locality. (Fig. 1.)

Remarks: When describing *N. cristata*, Braun cited the sterile specimens, Stuart Nos. 5, 217, and 788, as well as the fertile Stuart 219, and did not designate a type. Stuart 219 is selected as the lectotype because it is the only fertile specimen; the other syntypes are here excluded from var. *cristata* on the grounds that their size and dactyl characteristics make them referable to *N. breviteles*.

The oospore-wall decoration of *N. cristata* was originally described by Nordstedt (1889) after examining a Stuart specimen No. 753 from the type locality, but not part of the type. I examined Stuart No. 753 (later destroyed by fire) as well as the type, Stuart No. 219, and found that the spore-wall decorations did not correspond. My notes about specimen No. 753 indicate that its spore-wall decoration was similar to that shown in Figure 3*h* for var. *ambigua* and much coarser than that of 219, shown in Figure 3*j*.

The epithet *cristata* is attached to an extreme form among a range of plants bearing verrucate spore-wall decorations; the sparsely verrucate outer lamina, with some size differences, seems to warrant the maintenance of a variety distinct from the bulk of material placed under *N. cristata*, although only one specimen is known.

NITELLA CRISTATA var. AMBIGUA Braun, *Linnaea*, 25: 706 (1852). (Figs 1, 3*g*, *h*, 5*c*.)

Kuetzing, *Tab. Phycol.*, 7: 16–17, Pl. 41, fig. 1b; Braun and Nordstedt, *Abh. preuss. Akad. Wiss. Berlin* (1882): 14, 82.

Neotype: Creek on the Oxley Highway 5·4 miles east of Walcha, N.S.W., 5.iv.1958, Mary B. Williams 600.

Plant dioecious, medium to large, flexible. *Stem* about 0·5–1 mm. in diameter. *Sterile branchlets* simple or once to twice furcate, 1–6 cm. long, secondary rays 2–5, tertiary 2–3(–5); dactyls with 2–3(–4) cells, which gradually narrow distally to an acute, conical apical cell. *Fertile branchlets* usually twice furcate, the dactyls rigid and divergent; fertile whorls usually somewhat shorter than sterile, but not sharply distinct. *Oogonia* solitary or 2–3 together at any node, with (6)–7(–9) spirals. *Oospore* 0·32–0·45 mm. long; striae 5–7, prominently winged. *Oospore-wall* laminate, the outer layer strongly verrucate, the verrucae about 3–5μ in diameter, 2–3μ high, about 1 diameter apart, 10–12 per fossa; a middle layer finely baculate, the baculae slightly less than 1μ in diameter, about 1–1½μ high, 1 diameter apart, some being clavate in outline; the inner layer smooth. *Antheridium* 0·37–0·50 mm. in diameter.

Specimens Examined: QUEENSLAND: Highfields, F. M. Bailey (BRI 007729). NEW SOUTH WALES: Duval Creek, 12 miles N. of Armidale on the New England Highway, 22.iii.58, Mary B. Williams 420; dam on property of J. Kiefer, 3 miles N.E. of Armidale on Rockvale Rd., leg. J. A. Sutherland, 5.viii.55, MBW 335; do., MBW 333, ex culture; creek 5·4 miles E. of Walcha on Oxley Highway, 5.iv.58, MBW 600 (neotype); Hacking River at the Causeway, National Park, *ca.* 20 miles S. of Sydney, —.vii.57, MBW 419; Turon River, 6 miles S. of Capertee, 25.iv.54, leg. G. Packham, MBW P442; Weeney Creek, 1 mile W. of Kurrajong, 17.xi.56, MBW 405; temporary swamp, ¼ mile N.W. of Richmond in old meander of the Hawkesbury River, 25.v.58, MBW 421, 423; Parramatta, Rev. Dr. Woolls (MEL); shallow pool in dry creek bed, ¾ mile E. of Kingswood on the Great Western Highway, 17.xi.56, MBW 406; Werriberri Creek on the Camden-Oakdale Rd., 0·8 mile S.W. of The Oaks, 8.ii.57, MBW 408; dam on Gledswood property, 7 miles N.E. of Camden on the Hume Highway, 13.vii.55, MBW 271.1, 271.2; creek just E. of Mittagong on the Hume Highway, 29.v.56, MBW 393; roadside pond about 12 miles S.W. of Cooma on the Cooma-Jindabyne Rd., alt. *ca.* 3000 feet, 12.x.57, leg. B. Briggs, MBW 424. VICTORIA: Growing in fresh water at Box Hill (9 miles E. of Melbourne), G. French (MEL). TASMANIA: South Esk River, Dec., Charles Stuart 753 (destroyed by fire).

Other Illustrations: Kuetzing, *Tab. Phycol.*, 7: Pl. 41, fig. 1b.

Distribution: Common in pools and streams in New South Wales, Victoria and Tasmania. (Fig. 1.)

Remarks: Braun established var. *ambigua* on a specimen cited as "In aquis stagnantibus prope Melbourne Sept. 1852 legit Dr. F. Mueller. Inter N. Cristatam et tasmanicam quasi media". His description indicates rather that it was intermediate between *cristata* and *diffusa* and the name *ambigua* probably implied doubt as to its status. Chambers and Williams tabulate the differences between the three taxa and point out that, at the time of the original description, var. *ambigua* was distinguished

merely by having fertile whorls more diffuse and spores slightly smaller than *N. cristata*. These characters alone would not justify the retention of var. *ambigua* since fertile whorl morphology varies with environment (Chambers and Williams, 1959).

Investigations of all specimens conforming with Braun's descriptions of var. *ambigua* have shown that the outer spore-wall decoration is always coarsely verrucate, in contrast with that of the type specimen for *N. cristata* (Figs. 3*h* and *j*).

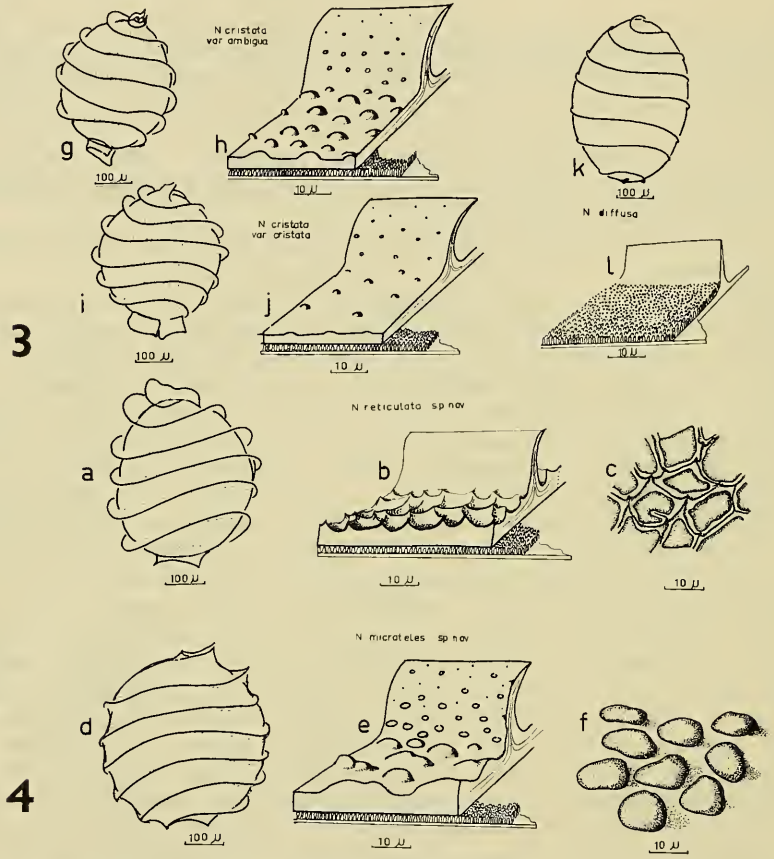


Fig. 3.—*g, h, N. cristata* var. *ambigua* Braun: *g*, oospore; *h*, three-dimensional reconstruction of spore-wall decoration, showing winged stria, outer verrucate lamina, middle baculate lamina and inner smooth lamina, from camera lucida drawings of MBW 600, neotype for var. *ambigua*. *i, j, N. cristata* var. *cristata* Braun: *i*, oospore; *j*, as in *h*, from Stuart 219, lectotype for *N. cristata*. *k, l, N. diffusa* Braun and Nordstedt: *k*, oospore; *l*, three-dimensional reconstruction of spore-wall decoration, showing winged stria, outer baculate lamina and inner smooth lamina, from c.l. drawings of MBW P439.

Fig. 4.—*a, b, c, N. reticulata*, sp. nov.: *a*, oospore; *b*, three-dimensional reconstruction of spore-wall decoration showing the winged stria, reticulate outer lamina, baculate middle lamina, and smooth inner lamina, from camera lucida drawings of MBW 346, holotype for *N. reticulata*; *c*, surface view of same. *d, e, f, N. microteles*, sp. nov.: *d*, oospore; *e*, three-dimensional reconstruction of spore-wall decoration showing winged stria, coarsely verrucate outer lamina, baculate middle lamina, and smooth inner lamina, from c.l. drawings of MBW 108, holotype for *N. microteles*; *f*, surface view of same.

Unfortunately the spore-wall decoration of the original specimen of var. *ambigua* has never been described; the specimen cannot be found among the collections of Melbourne or Kew and probably perished with Braun's types in Berlin.

Nevertheless it was felt that var. *ambigua* should be retained and its description amplified to include material with coarsely verrucate outer spore-wall, this being the

condition of all specimens seen. A neotype has been chosen from my own collections which fits the descriptions of var. *ambigua* given by Braun, *l.c.*, and by Braun and Nordstedt, *l.c.*; older material such as French's collection from Box Hill near Melbourne is too poorly preserved to be considered despite the desirability of its having been collected near the type locality.

NITELLA RETICULATA, sp. nov. (Figs 2, 4*a*, *b*, *c*, 5*a*.)

N. cristata sensu Nordstedt, *Acta Univ. Lundens*, 25: 29 (1889).

Holotype: Dune pond, Maroubra Beach, N.S.W., 20.vii.1955, Mary B. Williams 341.

Homoeoclema, arthrodactyla, pluricellulata, gymnocephala, dioecia.

Planta magna, fruticosa, rigida, ferme 20 cm. alta. *Ramuli steriles* 6 verticillo dispositi, 2–3 cm. longi, semel, partim bis furcati, radiis secundariis 3–5, tertiariis 1–3; *dactylis* inaequalibus, aliis minus 1 mm., aliis 2–5 mm., rigidis et divergentibus; bis aut ter, nonnumquam quater-cellulatis, cellulis sensim adversus apicem usque ad apicis cellulam acutam, conicam angustioribus. *Ramuli fertiles* plerumque bis furcati, non multum contracti, sed paulo breviores et rigidiores ramulis sterilibus, quasi racemos axillares et terminales formantes. *Oogonia* 1–3 in omni furca aggregata. *Oospora* 0·37–0·40 mm. longa, striis 5–6, clarissime alatis. *Oosporae membranum* lamina exteriore valde reticulata, luminibus quasi reticuli 4μ diam., muris ferme 2–3μ altis, in nodo omni spissatis et elevatis, alibi tenuibus; lamina media tenuiter baculata, baculis minus 1μ diam., et ferme 1μ altis diametro suo separatis; lamina interiore omnino levi. *Antheridium* 0·46–0·50 mm. altum.

Planta a *N. cristata* distinguenda oospora magna et oosporae membrano reticulato; a *N. microteles*, ramulis sterilibus bis furcatis et dactylis longioribus.

Plant large, bushy, rigid; about 20 cm. high. *Sterile branchlets* 6 in whorl, 2–3 cm. long, once, partly twice furcate; secondary rays 3–5, tertiary 1–3; dactyls unequal, some less than 1 mm., some 2–5 mm., rigid and diverging, 2–3, occasionally 4-celled, the cells gradually narrowing distally to an acute conical apical cell. *Fertile branchlets* regularly twice furcate, not greatly contracted, but somewhat shorter and more rigid than the sterile, forming axillary and terminal clusters. *Oogonia* 1–3 together in any fork, with 6–7(–8) spirals. *Oospore* 0·37–0·40 mm. long; striae 5–6, prominently winged. *Oospore-wall* with an outer layer strongly reticulate, the meshes 4μ across, the muri about 2–3μ high, thickened and raised at the nodes, elsewhere thin; middle layer finely baculate, the baculae less than 1μ in diameter, about 1μ high, 1 diameter apart, some being clavate in outline; and the innermost layer completely smooth. *Antheridium* 0·46–0·50 mm. high.

Species Examined: NEW SOUTH WALES: Holotype, as above.

Distribution: On the coasts of New South Wales and Victoria in brackish waters up to half the chloride concentration of sea-water; also inland Victoria, *fide* Nordstedt, *Acta Univ. Lundens*, 25: 29. (Fig. 2.)

Remarks: Under *N. cristata* Nordstedt gives three localities for plants with reticulate spore-walls: Goulbourne River (Victoria), Lewis No. 6; Genoa (Victoria), Jan. 1887, W. Bauerlen No. 341; Hurstville, near Port Jackson (New South Wales), 1884, Whitelegge No. 2. The last two specimens were destroyed in the New England fire. They were probably referable to *N. reticulata*, since the habitats, being coastal, could have been saline. A Goulbourne River specimen collected by Lewis, but with no number (MEL), cannot be determined with certainty because it has no ripe spores.

N. reticulata is distinguished from *N. cristata*, *N. microteles* and *N. diffusa* morphologically by its reticulate spore-wall, and ecologically by its preference for saline habitats, which would effectively isolate it from the freshwater species. It is distinguished from *N. gelatinosa* Braun and *N. tasmanica* (F. Mueller) Braun by the fertile whorls which are diffuse and not enveloped in mucus.

NITELLA MICROTELES, sp. nov. (Figs 2, 4*d*, *e*, *f*, 5*b*.)

N. cristata Braun, *Linnaea*, 25: 706, pro parte.

Holotype: Creek on the Monaro Highway 3 miles E. of Nimmitabel, N.S.W., N.S.W., 7.ii.1955, Mary B. Williams 108.

Homoeoclema, arthrodactyla, pluricellulata, gymnocephala, dioecia.

Planta robusta rigidaque, pallide viridis. *Internodia* ferme 1 mm. diam. *Ramuli steriles* 6 verticillo dispositi, 1–2 cm. longi, obscure semel furcati, radiis secundariis (i.e. dactylis) 2–3, brevissimis et inaequalibus, plerumque minus 1 mm. longis, 2–3 cellulatis, cellulis inferioribus sensim adversus apicem angustioribus, apicis cella late conica, acuta. *Ramuli fertiles* bis furcati, ferme 2 mm. longi, radiis rigidis et

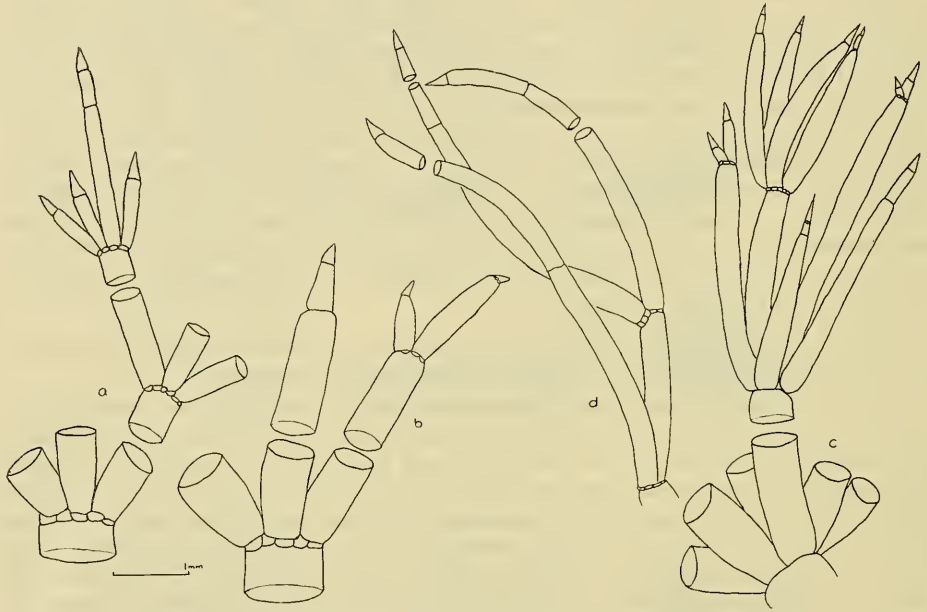


Fig. 5.—Camera lucida drawings of sterile branchlets: *a*, *N. reticulata*, sp. nov., from MBW 346; *b*, *N. microteles*, sp. nov., from MBW 108; *c*, *N. cristata* var. *ambigua* Braun, from MBW 600; *d*, *N. diffusa* Braun and Nordstedt, from MBW P439.

divergentibus; verticillis positi valdissime contractis, a sterilibus conspicue distinctis, capita aut terminalia aut axillaria formantibus. *Oogona* 0·65 mm. longa, 1–3 in furca omni aggregata. *Oospora* 0·37–0·44 mm. longa; striis 5–6, clarissime alatis. *Oosporae membranum* lamina exteriore valde verrucata, verricis ferme 3–5μ diam., 2–3μ altis (nonnullis quidem aliquantum ad ferme 9μ elongatis), 1–2 diametris suis separatis, ferme 8 in fossa omni positis; lamina media tenuiter baculata, baculis minus 1μ diam., ferme 1μ altis, diametro suo separatis; lamina interiore omnino levi. *Antheridii* mensura ignota.

Planta a *N. cristata* distinguenda ramosis sterilibus unifurcatis, dactylis brevissimis, verticillis fertilibus valde contractis, spore magna.

Plant dioecious, stout and rigid, pale green. *Stem* about 1 mm. in diameter. *Sterile branchlets* 6 in a whorl, 1–2 cm. long, obscurely once furcate, the secondary rays (dactyls) very short but unequal, usually less than 1 mm. long, with 2–3 cells, the ultimate two narrowing distally, the apical one broadly conical and acute. *Fertile branchlets* twice furcate, about 2 mm. long, the rays being rigid and diverging; the fertile whorls extremely contracted, and sharply distinct from sterile, forming terminal or axillary heads. *Oogonia* 0·65 mm. long, 1–3 together in all forks, with 6–7(–8) spirals.

Oospore 0·37–0·44 mm. long; striae 5–6, very prominently winged. *Oospore-wall* with outer layer strongly verrucate to rugulate, the verrucae about 3–5μ in diameter, 2–3μ high, 1–2 diameters apart, some elongated to 9μ, forming rugulae with middle layer finely baculate, the baculae less than 1μ in diameter, about 1μ in height, with inner layer completely smooth. *Antheridium* unknown.

Specimens Examined: New South Wales: Holotype, as above; Long Plains Creek, on the old Adaminaby-Kiandra Road, 5 miles from Adaminaby, 8.ii.1955, MBW 106, 111, 362 ex culture; creek on the Adaminaby-Jindabyne Road at Braemar, 8.ii.1955, specimens destroyed. Victoria: South Esk River, Tasmania, C. Stuart, 5, 217 and 788 (MEL).

Distribution: Tasmania; New South Wales, alpine regions, in slowly running streams with soft muddy substratum. (Fig. 2.)

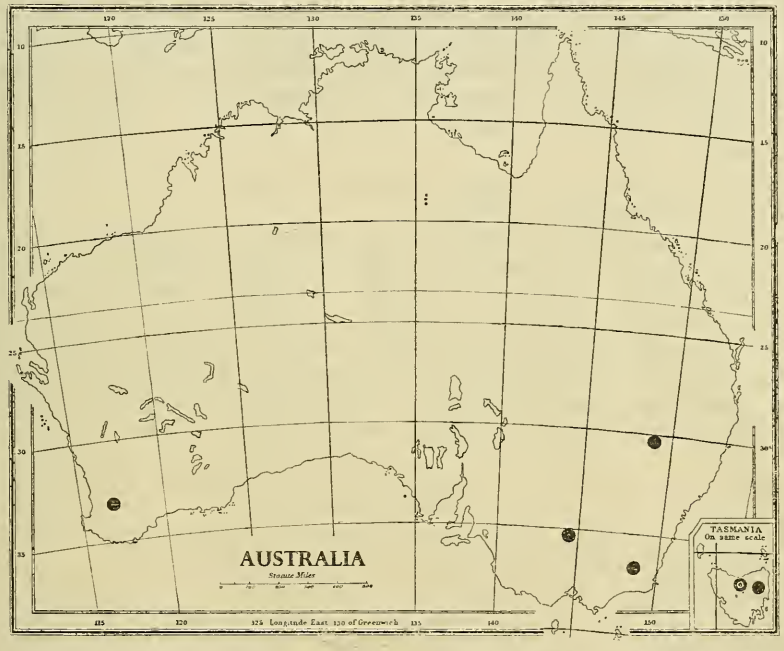


Fig. 6.—Distribution of *N. diffusa* Braun and Nordstedt ● and its type locality ◯.

Remarks: The verrucate spore-wall indicates that this material has a close affinity with *N. cristata* var. *ambigua*, but the large size and restricted forking differentiate it. Its distinctive habit and fruiting behaviour in different experimental environments (Chambers and Williams, 1959) suggest that it should be treated as a separate species. It is distinguished from *N. diffusa* and *N. reticulata* by the verrucate spore-wall, and from *N. tricellularis* Nordstedt, which it resembles vegetatively, by being dioecious.

Nitella diffusa Braun and Nordstedt, *Abh. preuss. Akad. Wiss. Berlin* (1882): 14, 80. (Figs 3*k*, *l*, 5*d*, 6.)

Braun in J. D. Hooker, *Flora Tasm.* II: 159–160 (1860) sine descript.; Braun, *Abh. preuss. Akad. Wiss. Berlin* (1867): 797, nom. tant.; Nordstedt, *Acta Univ. Lundens*, 25: 13, 28 (1889); Groves and Allen, *Proc. Roy. Soc. Qd.*, 46: 49 (1935).

Holotype: Gunn 1574, hab. Distillery Creek, Launceston: Rivulet near Penquite (non vidi).

Plant dioecious, loose and flexible, slender. *Sterile branchlets* 6 in a whorl, to 1 cm. long, 2, partly 3 times furcate; secondary rays fairly regularly (2)–3; tertiary rays 2–3; dactyls not greatly divergent, about 5 mm. long, 2–3(4)-celled, the lower cells

not narrowing appreciably, the ultimate one short, conical acute. *Fertile branchlets* like sterile; fertile whorls not sharply distinct from sterile, 2–6 mm. in diameter, forming loose terminal clusters. *Oogonia* solitary or 2–3 together, in any fork, with 6–8(–9) spirals. *Oospore* 0·29–0·37 mm.; striae 6–8, fairly prominent. *Oospore-wall* with outer layer densely baculate, the baculae of the order of 1μ in height, less than 1μ in diameter, about 1 diameter apart; with inner layer smooth. *Antheridium* 0·30–0·48.

Other Illustrations: Braun and Nordstedt, *Abh. preuss. Akad. Wiss.* Berlin (1882): figs. 155–157; Nordstedt, *Acta Univ. Lundens*, 25; Fig. 8.

Specimens Examined: Queensland: None of the specimens cited by Groves and Allen, *l.c.*, is complete enough for determination. I believe that many of them are referable to *N. cristata* var. *ambigua*. New South Wales: Piangobla, Moongulla (W. of the Barwon River), 16.viii.1955, leg. J. T. Waterhouse (specimen destroyed); Bett's Creek, Kosciusko State Park on the road to Mt. Kosciusko (specimen destroyed); small pond near Spencer's Creek, Kosciusko State Park, ¼ mile upstream from the road to the summit, 3.i.1954, leg. A. T. Hotchkiss, M.B.W. P439, P443 and dried specimens made from this preserved material; Edward River, F. Mueller, viii.1875 (MEL). Tasmania: St. Paul's River, Stuart 751 (MEL). Western Australia: Karoling, R. Helms, 17.xi.1891 (MEL).

Distribution: Possibly Queensland; New South Wales mainly from alpine regions; Tasmania; Western Australia. (Fig. 6.)

Remarks: Chambers and Williams (1959) discuss the typification of *N. diffusa*. Mr. J. H. Willis has kindly examined the specimen at Kew bearing the same label as the type, and which he believes is an isotype. He reports that it has fertile whorls shorter than the sterile, that the spore is 290μ long and is "very minutely reticulate". This is the surface appearance of the condition which I describe as baculate (Fig. 3). On the assumption of other charologists that spore-wall decoration is a conservative character, I have maintained *N. diffusa* as a separate species. Specimens which I have interpreted as *N. diffusa* show much longer dactyls than *N. cristata*. (Fig. 5.)

Key to the dioecious non-gelatinous homoeoclemous Pluricellulatae of the genus Nitella *Ag. emend. Braun.*

1. Sterile branchlets appearing simple in lower whorls, 1, partly 2 times furcate in upper whorls, the dactyls unequal but usually some longer than 1 mm.
2. Outer oospore-wall or wings with coarse verrucae or reticuli about 2μ-3μ in height or diameter, visible in low power.
3. Outer spore-wall and wings, or wings alone, set with verrucae about 2μ diameter, 1-2 diameters apart ..... *N. cristata* Braun.
4. Verrucae sparsely and irregularly distributed on wings alone or occasionally on the body of the spore: inner spore wall set with very fine baculae about 1μ in diameter and height: spore 0·34-0·37 mm. long ..... *N. cristata* var. *cristata*.
4.* Verrucae densely distributed on wings and body of spore; inner spore wall set with very fine baculae about 1μ in diameter and height: spore 0·32-0·45 mm. long ..... *N. cristata* var. *ambigua*.
3.* Outer spore-wall and wings strongly reticulate, the muri of the reticulum thickened and raised at the nodes, elsewhere thin, about 2μ-3μ high; spore 0·37-0·40 mm. long ..... *N. reticulata*.
2.* Outer spore-wall closely set with very fine baculae about 1μ in diameter and height, appearing granulate in surface view; spore 0·32-0·38(-0·43) mm.; dactyls of fertile whorls longer than gametangia, not rigid and divergent ..... *N. diffusa*.
1.* Sterile branchlets appearing simple throughout, really obscurely once furcate; the dactyls usually all less than 1 mm. long; fertile branchlets sharply contracted, 2 times furcate; spore 0·36-0·44 mm. long. outer wall strongly verrucate, the verrucae about 2μ-3μ in diameter, or elongated to about 9μ, forming rugulose ..... *N. microteles*.

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